THE CYPRESS PROJECT

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INTERIOR PLANTS: THEIR FUTURE IN INDOOR AIR QUALITY

By

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NASA Studies

In 1980 NASA's John C. Stennis Space Center, located in south Mississippi, first discovered that common office and house plants could remove volatile organic chemicals (VOCs) from sealed test chambers. NASA's studies, published in 1984, demonstrated interior plants' ability to remove formaldehyde from test chambers. These findings were enthusiastically received by the public and, in particular, the interior plantscape and nurserymen industries. Realizing the potential value of this research, the Associated Landscape Contractors of America (ALCA) jointly funded a two-year study with NASA to further evaluate the ability of twelve common interior plants to remove formaldehyde, benzene, and trichloroethylene from sealed chambers. Because of positive results from this study published in late 1989, ALCA created the Plants for Clean Air Council (PCAC). PCAC, a nonprofit organization, continues to support *living* plants as a method for improving indoor air quality (IAQ).

As with any new, innovative technology, there were some critics. The most vocal critics complained that sealed chamber studies could not be extrapolated into "real world" environments. To address these and other relevant concerns, NASA developed a small, tightly sealed structure called the "Biohome." The Biohome, architecturally designed with a futuristic look, was engineered to achieve maximum air and energy closure. Insulation in the walls (12" thick) provided a thermal insulation value of R-40, making it super energy-efficient. Because the interior was constructed of plastic and other synthetic materials, outgassing of many VOCs was anticipated. Upon entering the Biohome, one experienced symptoms of "sick building syndrome" such as burning eyes and throat and respiratory discomfort.

Air samples were taken before and after the addition of interior plants and an activated carbon/plant filter. Analyses by gas chromatography/mass spectrometry confirmed that plants can improve indoor air quality in a "real-world" environment. *(See Fig. 1)* Six large philodendrons *(Philodendron domesticum)* and one fan-assisted activated carbon/planter containing golden pothos *(Epipremnum aureum)* were placed inside the Biohome. After several days, air samples were again analyzed and showed substantial reduction of VOCs. Chemical analyses of VOC removal were important for scientific validation. However, the ultimate proof was exhibited through the individuals who entered the Biohome and no longer experienced symptoms of "sick building syndrome." The

Biohome study provided proof that (1) plants can become an integral component in achieving a healthy building and (2) chamber studies can be extrapolated to energy-efficient buildings with reduced ventilation.

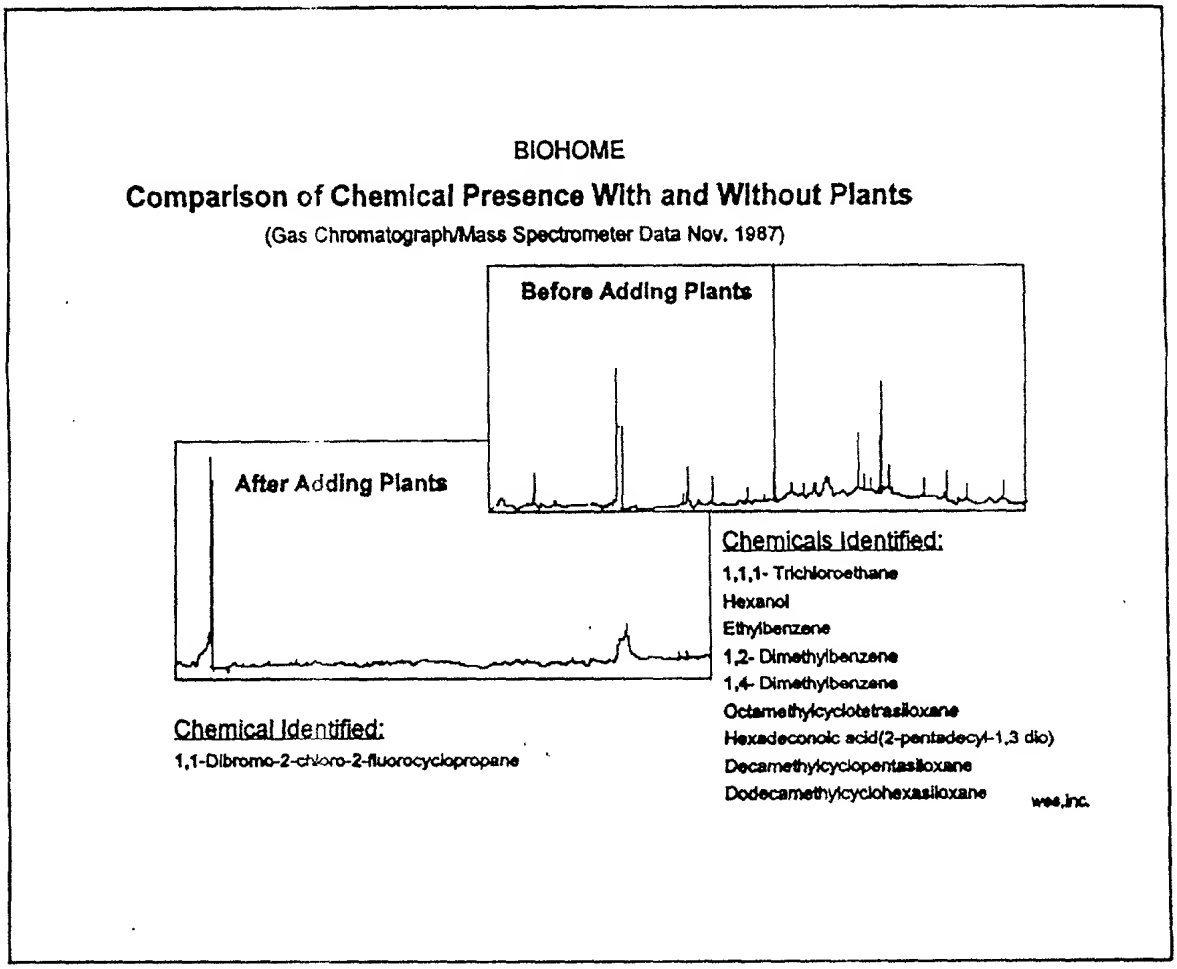

Figure 1

Upon completion of these studies in April 1989, a section of the Biohome provided living quarters for a university summer student. The remainder of the building housed a hydroponic plant cultivation system for treating and recycling wastewater. The student lived in the Biohome during the summer without experiencing any indoor air quality problems or "sick building syndrome" symptoms. Interior plants were successfully used to alleviate sick building syndrome in this super energy-efficient structure.

PCAC--WES, Inc. Studi

Research, begun in 1990 and co-sponsored by the PCAC and Wolverton Environmental Services, Inc., continues to expand upon the NASA research. Approximately forty-two species of interior plants have been evaluated for their ability to remove various indoor air contaminants from sealed chambers. Experiments were conducted and technical reports published seeking to answer legitimate concerns about placing large quantities of plants in energy-efficient buildings for the specific purpose of improving IAQ.

After more than ten years of extensive research, both laboratory and "real-world," we now have a basic understanding of how plants function to remove indoor pollutants. Most interior plants, whose origins began underneath the canopy of tropical rainforests, have evolved over millions of years. These plants naturally thrive in dimly lit, warm, and humid conditions. Nature has equipped these plants with the ability to culture microbes, on and around their roots, which can supply their nutritional needs by rapidly biodegrading and mineralizing (composting) leaves, animal waste, and other jungle debris. Leaves tannic acids, and humic acids contain complex organic structures that plants' root microbes must biodegrade. When these plants are placed in indoor environments, the biological processes of the microbes continue. Because chemicals such as formaldehyde, benzene, xylene, etc. have structures similar to components found in tannic and humic acids, the microbes can rapidly degrade these and hundreds of other indoor air pollutants. When interior plants are placed inside buildings, especially during winter months when air in these buildings can become dry, increased transpiration rates help move air down into the root area. If this air contains VOCs, microbes living on and around the roots can biodegrade these pollutants.

There is also a well established scientific basis for how plant leaves can absorb organic chemicals and translocate them to the root zone where they are biodegraded by microbes. Therefore, plants have means of moving air and air polluting substances down around their root area where many microbes thrive. The latest research indicates that plants can suppress airborne microbes surrounding their leaves, even when humidity levels are increased by plant transpiration.

In an effort to enhance the ability of plants to remove pollutants, fan-assisted planter/filters were developed that increase the air flow to the plants roots. Second generation planters, available this fall, will increase the air purifying effectiveness of a plant by as much as 200 times, remove airborne microbes, and function as a humidifier.

In October 1989, a 1218 ft² addition, added to my existing home in Picayune, Mississippi, included an indoor air purification/wastewater treatment system. A L-shaped hydroponic planter, built around the outer interior walls of the sunroom, serves four main functions: (1) aesthetics, (2) air purification, (3) humidity control, and (4) treatment of wastewater from an adjacent bathroom. A central heat pump distributes air from the sunroom throughout the addition. This unique, patented system has exceeded all expectations in functionality, ease of maintenance, and rainforest-like ambience. Plants, common in interior landscape designs, fill the planter

This system is monitored for temperature, humidity levels, and airborne microbes. Contrary to the critics belief, humidity levels are sustained within a comfortable range of 40 - 60 percent. Volatile organic chemicals are below detection limits. More important, no one has experienced any of the symptoms associated with "sick-building syndrome." Airborne levels of molds and bacteria have proven to remain 50-60 percent below levels found in plant-free rooms . the exact opposite predicted by the EPA. During winter months, the sunroom temperature is lowered to 50 - 55°F at night to reduce energy consumption. This plant-filled, energy-efficient home has been occupied since 1989 without any symptoms of "sick building syndrome." Again, this is a "real world" application using interior plants for the primary function of providing excellent IAQ.

"Real World" Public Building

An interior designed planting, for the specific purpose of maintaining a healthy indoor environment, was installed in a new math/science building on the campus of Northeast Mississippi Community College, Booneville, Mississippi. State and college officials wanted a building that would be a model of energy-efficiency and environmental technology. Through the persistence of Assistant Administrator James Williams, the plant-based air purification system became an integral component of this healthy building. This small-town college had the courage to approach the 21st century with an innovative, cost-effective means of maintaining energy-efficiency, while assuring clean indoor air.

The building itself is a teaching tool for various scientific disciplines. A two-story atrium, common in office buildings today, is surrounded by offices and conference rooms. A planter system encompasses the open atrium on the second floor. A variety of common office plants derive their water and nutrient source from the wastewater of two staff restrooms. These plants and their associated microbes also purify the wastewater. Excess waste is gravity-fed to the landscaped shrubbery surrounding the exterior of the building where further treatment is accomplished Ventilation in this portion of the building can be reduced to near zero, for super energy-efficiency. Because it is tightly sealed and the ambient air recirculated, it provides a perfect test for the ability of plants to maintain good air quality. Since occupancy of this building in August 1993, there have been no complaints of indoor air quality or "sick-building syndrome." In fact, office space in this portion of the building is in the greatest demand as everyone enjoys the superior air quality and aesthetic beauty only designed interior plantings can provide. This example is further proof that plants can be used to maintain energy-efficiency and healthy indoor air. The ultimate goal for every building is to provide a comfortable, productive environment that is as cost-effective as possible.

Clean Air Message

In 1990 the Plants for Clean Air Council conducted an extensive media campaign to educate the public about the ability of plants to improve indoor air quality. Because of this educational campaign, millions of people throughout the world are now aware of the beneficial health effects of having *living* plants indoors. A poll in 1991 of 11,000 members of the International Facility Management Association (IFMA) revealed that 26 percent of the respondents said that they worked

in facilities with "green plant programs for the purpose of air pollution control."

Plants alone may not always provide the total solution to indoor air quality. An exception may be a plant-filled atrium where the air is circulated from the atrium throughout the building. Improvements in source management (allowing building materials and furnishings to outgas before their use), complete air distribution, preventative maintenance, etc. all play an integral part in creating and maintaining a healthy building. For plants to be a reliable component in air quality management, two changes must occur. (1) Ventilation must be reduced, restoring energy-efficiency. Neither mechanical nor biological filtration systems can work properly if a building's air supply is frequently replaced with outside air. (2) Fan-assisted planter/filters, working in tandem with plants, are required whenever serious indoor air pollution problems exist, such as in NASA's Biohome.

The Use of Plants . . . Looking Into the 21st Century

In an interview published in 1994 in the *EPA Journal*, Carol Browner, Administrator of the EPA, stressed the need for new technologies. Her statement in part follows:

> "Perhaps nothing is more essential to achieving our nation's environmental goals than developing and deploying new technologies for environmental protection. The technologies we have today are not adequate to solve many of today's environmental problems, let alone the challenges that lie ahead . . We need new technologies that work better and cost less.
>
> Traditionally, enforcement personnel have been reluctant to grant exceptions for businesses that make bona fide attempts to comply using an innovative approach but need extra time or fall short of the regulatory mark. As a result, the same old technologies are used over and over, year after year, freezing out newer and more effective options . . We hope to lead other federal, state and local agencies to reduce barriers to innovation."

It is hoped that Ms. Browner's enthusiastic support for innovative technology will transcend into the EPA's Indoor Air Division. During the past several years, the Indoor Air Division has discouraged the use of plants in buildings other than for aesthetics. Energy-efficient buildings that use plants for aesthetics as well as human health and well-being are inevitable. Natural solutions to indoor air quality problems are poised for public acceptance in spite of the bureaucracy.

Millions of people have heard the PCAC "clean air message" of how plants can help clean indoor air. An article in the March 1995 issue of Facilities Design Management states, "Dr. Wolverton's research and other studies by accredited scientists are largely accepted in the scientific community. Government agencies don't question whether or not plants work, but how effective they

function in an office environment." A nostalgic review of the last six years reveals just how widespread and readily accepted by the public the "clean air message" has become. However, there are still many hurdles to overcome.

New, innovative technologies must find ways to gain acceptance into the building industry. Barriers have been established by industries that dominate professional standard setting committees. Because of the strong influence these professional societies possess, it is difficult for new technologies to break into this market. The time is right to implement the approach that plants can improve IAQ and conserve energy through reduced ventilation.

When the Occupational, Safety and Health Administration (OSHA) began public hearings last fall on its proposed regulations for IAQ, representatives from all concerns lined up to testify; the tobacco industry, building owners and managers, engineers, labor unions, etc. Besides the entrenched players, one of the industries newest associations made its initial appearance at the hearings to present the position of its members. Representatives from the Clean Air Device Manufacturers Association (CADM) testified that the association agrees with OSHA's concern over IAQ problems but, air cleaning devices have been overlooked as an option for cleaning indoor air. Supporters of plants as air purifiers must be represented at future meetings with OSHA or EPA

The quest for energy-efficiency and continued increases in ventilation are not compatible. Source management and the use of plants and other air cleaning devices should all receive consideration in the battle for good IAQ and energy-efficiency The climate is right for Congress to mandate the use of cost-effective, innovative technologies for solving environmental problems. The step-by-step development of such a technology for improving indoor air quality is outlined in this paper. No additional federal funding is required for the use of this natural technology. The need is for the EPA, OSHA, and other regulatory agencies to encourage, not discourage, the use of plants for improving indoor air quality in energy-efficient buildings.

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THE CYPRESS PROJECT INDEX:

Background Of the Invention
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Field Of Invention

We all know that plant's play a vital role in the maintenance of life on earth. All energy used by living organisms depends on the complex process of Photosynthesis. The rate of photosipiration has fallen by over 10% in 30 years. One gram of chlorophyll can produce many liters of oxygen per hour and clean the air in the same process.

One of the most serious threats to life is the possibility of rapid warming of the earth. From the accumulation of heat trapping gases, such as air pollution we know is breaking down our ozone layer and the temperature change per decade is .9 to 1.8 degress farenheit.

Plants are the only thing I know of that can clean out the air. They use heat and rays from the sun as food and energy.

Summary of the Invention
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Brief Summary

This is where The Cypress Project comes into vision. It is so simple that it is hard to believe we are not already doing it.

I've designed a way to put tree's and plant's on barren roof tops and using the condensate water from the air conditioning to saturate them. The slime and algae will fertilize them. We can also provide shade for the building which will cut down energy usage and is a great insulator.

The most important thing this will do is help clean out the enivironment, for future mankind. Just think of the area we are talking about , whole cities have a great amount buildings, structures, homes for the development of The Cypress Project.

We can construct homes with concrete roof's and parapit walls on them and mount the a/c unit on top, in doing this we can figure out how much pollution the people are causing by their vehicles, household products, lawnmowers, and put the amount of vegetation on the roof top to make up the difference in what they are polluting. Also other trees around there homes would help in the industrial world. We can do the same for factories that pollute the air. We make whole structures specifically designed to hold water and plants.

The ocean can also benefit from The Cypress Project as we can make a structure in a square large area with sea plants all over them as many as needed and the factories pollutants can come right into the middle of the area. This is how big The Cypress Project can or will become.

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Descrption of Drawings.

My invention is designed with Florida in mind because of hurricanes. Making an aluminum planter that the roots can grasp the inside of it and have legs on it to bolt down to the roof and be able to remove it in hole if we need to reroof the roof from leaks.

If a hurricane hits the trunk will stay but the branches will come off.

I have an article from NASA given to me that has proof in what I am saying. I do not believe we should give up on the outside environment so quickly. What will man do if the other man is working in clean air buildings and the other man has to work outside. Do not let man have the same fate as what we have found on Mars and the Biodome if it is really there.

I have also made a water saver system for roof's that have no a/c units or emergency water in case of a drought. Using a common sprinkler system, the Cypress water saver is deigned to turn the pump off when it rains.

I would like to call the new trades man for this construction The Cypress Tradesman.

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Identifying Indicia

A.) Planter will be made out of aluminum, including legs, to be able to last for decades and being bolted down to a concrete roof up to code. I am currently working with an engineer to make sure the plants will stay and the tree trunk will stay in place and only branches will fly off.

B.) Top view showing inside of planter before dirt is added. Showing the root brackets to let the roots grasp them and the 3 drain holes.

C.) Drain holes will be in round to let the water come out 4 inches in diameter.

D.) Root brackets will be made of aluminum from 5 inches long 5/16 wide for bush planters. Tree planters will be be bigger of course 7 inches long to ½ thick. Bolted in from the outside after hole is drilled through planter washers will also be used.

E.) Planters legs will be adjustable for different roof thickness and to lift planter up to roof to redoor roof when a leak occurs also all aluminum. Bolts thru legs will be made a stainless steel to be stronger, top of legs to bottom of planter will be welded on all cypress planters. Support rails where necessary.

F.) Large cypress planter for cypress or oak trees. Shown here we have 8 I beems with the darker one's on the bottom of the planter. Spot welded to the planter and the other four placed on top of the other. You will have a 4 inch gap between the I beems going from left to right. Getting the roots. Go under the I beems making the tree stay in place even when a hurricane comes by the building will have to blow down to remove the tree. There will also be shade plant's in the planter around the tree or tree's also the root brackets will be in place to let small roots grasp the cypress planter.

G.) I beem and aluminum rails.

H.) Side view showing inside the planter and leg assembly there will be 16 legs in total.

3.) Bar joist roof application system. Depending on space of bar joices usually 4 ft but large commercial buildings same time have up to 10ft but will be done with the same engineer drawings to pass florida code which is the toughest code in America .

J.) Side view with tree and plants.

4.K.) New York showing use of The Cypress Project using cypress side wall planters.

L.) Side wall planter being bolted with red head 3/8 concrete bolts or other to hold planter to wall

M.) Inside side wall planter many different sizes will be made depending on the application.

5.) Looking down at a roof showing how an a/c package unit waters the planters all year round and feeds them . Only 2 planters can be fed by one a/c unit to prevent future problems , drain lines clogging. Also on some roofs where stairs and doors provide regular access to the roof. I will make a aluminum bench bolted to the roof. For getaway or to look up to the heavens.

6.) Many planters on only one air conditioner.

O.) A/C unit feeding planter wit a condensate pump attachment with a float switch in it that shuts the a/c unit off. Telling the customer or homeowner to check on there tree's by calling a qualified a/c company.

P.) Suction line condensate watering sideview system. By letting the suction line run along the top of the planter with no installtion which will cause it to seat we will make beads of soder under the suction line and it will drip in that spot. Will probably have to fertilize the planters.

Q.) Top view of suction line condensate watering system

R.) Making a larger condensate pump so it will not clog-up so quickly with slime.

7.) Condensate pump watering many plants.

8.) Cypress project water saver. Desinged for the project that has no air conditioners on roof tops. It will be hooked up to the buildings sprinkler system or put pump and water supply on roof where applicable. It is designed to not over water trees. During the rainy season which when the saver fills up from a storm will cause the float switch to rise cutting power to the sprinkler pump and when it evaporates.The sprinkler time will still be running so only when it rains will it operate by not allowing power from the time to go to the pump motor. It will be able to use on many applications around the world.

8.S) Cypress projects water saver, saver. This one is designed to use without electricity. The rain water goes in and fills the bottom casuing the float switch to rise making a contact open breaking on 240 volt leg to the sprinkler pump. Not letting it come on till the water evaporates.

Table:

A) Plastic float arm
B) Overflow hole
C) Float
D) Contacts
E) Emergency overflow hole
F) Special designed contacts
G) Access holes, Knockout for electricity from pump and back to pump.

9.V) The future of The Cypress Project using the same principle in the oceans as the air. By building a structure in the ocean so when pollutants from factories can emerge right into a weed forest that will start cleaning it out in that immediate area.

T.) Having a parking lot under water many stories with 5 windows in the concrete ceilings to let light shine through the structure with it full of plant life will also attract ocean life. Yes we can build it on the land next to a factory using the same process.

U.) Making ceramic roof tile with grooves on it so grass can be put on it and grab hold of it and a lip on the bottom edge to hold the dirt from sliding off. I know of certain grasses that do not grow tall. But outward.